No. 92 May 2000

solplan review

the independent journal of energy conservation, building science & construction practice

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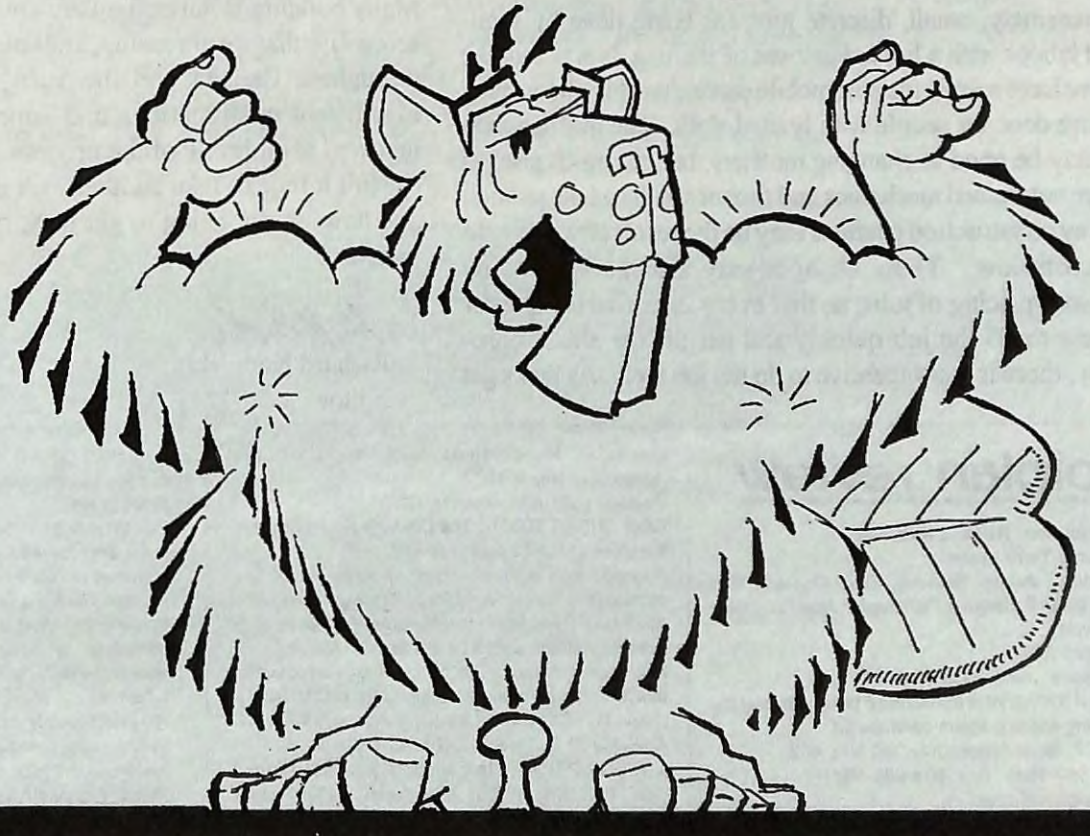
Building Durability



From the Editor . . .

We have developed a sophisticated management process for building houses cost-effectively. Management courses are virtually mandatory for any formal builder recognition. Most larger builders, if they do not have one or more MBAs, will have other management professionals with equivalent credentials on staff or on a retainer.

I am beginning to wonder, though, if we have not grown too smart for our own good. The weight given to "bean counting" management goals which strive to maximize bottom line returns may be coming at the expense of quality. Yes, I know that profit margins are often pathetically low in this industry, but think that, at the core of many of our problems, is excessive cost cutting. Not enough recognition is being given to the intrinsic value of the product we create.

Construction industry management approaches have evolved out of models in the manufacturing sector and currently fashionable business philosophies that champion the employment of minimum wage, semi-skilled workers. This becomes easier with the increased use on-site of manufactured products and pre-assembled components. Many job-site tasks have been simplified and have taken on a role not unlike that of a factory assembly line.

Increasingly, small, discrete jobs are being done by semi-skilled labour with a limited amount of training. It is not unlike what we have seen in the automobile service world, where many tasks are done by people with limited skills. The muffler shop guys may be good at changing mufflers, but not much else, as they are not trained mechanics and cannot see the whole picture.

Many construction changes may be the result of wanting to keep costs low. These changes may also be spurred by piecework pricing of jobs, so that every incentive is there for the crew to do the job quickly and get off the site. Consequently, there is less incentive to do the job well. As tasks get dumbed down, fewer qualified trades people are involved, thus further lowering the overall quality of the work done. Increasingly, essential tasks are performed by unskilled labour - too often working at minimum wage.

What is often forgotten is that there are few truly simple, unskilled labouring jobs on a construction site. In reality many of these seemingly menial tasks are vital to the proper performance of the building.

This new industrial management style may have resulted in changes that have gone too far. It also tells the trades workers on the job site that we have little respect for those who work on the construction site, simply reinforcing an image that manual work is for those who cannot make it elsewhere (in management or high-tech?). We are already seeing this with an increasingly ageing trades force. Where will the next generation of tradespeople come from? How are we going to interest kids in getting involved in the construction industry if the workers on the job site get little respect?

A big and expensive downside rears its ugly head during boom times when pressures lead to reduced supervision. We have seen this in the Vancouver area with the massive building envelope failures, but it is not unique to Vancouver. Many building failures, be they envelope failures or other screw-ups that we are seeing, and have seen in the recent past throughout Canada and the USA, can be attributed to insufficient qualifications and supervision by the people involved at all levels of the process.

Isn't it time to take another look at how we do business, and how we are going to get new, qualified talent into the industry?

Richard Kadulski,
Editor

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ISSN: 0828-6574
Date of Issue: June 2000
SOLPLAN REVIEW is published 6 times per year by: the drawing-room graphic services ltd.
Box 86627, North Vancouver, BC V7L 4L2
Tel: 604-689-1841 Fax: 604-689-1841
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Canadian Publications Mail Product Sales Agreement No. 454532
Postage paid in Vancouver, BC.
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Building Durability

How Long Will a Building Really Last?

We expect buildings to last many years. Premature deterioration of buildings, resulting in costly repairs and disruption, is an increasing problem world wide. Problems often emerge in areas experiencing a development boom. The annual costs related to such repairs and disruptions have now reached multimillion dollar levels. However, building codes do not establish explicit targets for how long buildings should last, so it is possible to have a code compliant structure that will suffer failure within a short time of occupancy.

Traditional construction methods and details evolved as a result of a long process of trial and error, using a few designs and materials appropriate to a location. In recent years we have moved away from this climate sensitive construction approach. The "modern" way is to use more varied building designs with a wide variety of new, high tech, manufactured products, regardless the specific location. Often new materials are used before we fully understand their properties and performance limitations. However, all materials have limitations. All have a given life span before they loose their functionality, require upgrading or maintenance.

How do we judge the durability of buildings?

Surprisingly, no guidelines have existed until today. Recently issued CSA Standard ***S478, Guideline on Durability of Buildings***, sets out for the first time in North America a set of recommendations to help builders and designers create durable buildings. The information contained is neither new nor revolutionary, and was developed as an aid to owners and designers. The guideline provides a framework within which durability targets may be set and suggests criteria for specifying the durability performance of buildings in terms that are commonly used but that were previously undefined.

How we achieve long lasting buildings is becoming more of a challenge as building codes shift away from the traditional prescriptive regulations to performance-based standards. The service-life requirements and design choices that may affect durability must be thoroughly discussed and agreed upon by all concerned parties.

The issue of durability is addressed to a limited degree in many documents, including the National Building Code (NBC), materials and installation standards, and manuals of good building practice. However, durability is often implicit rather than explicit, and is generally limited to particular phases in a building's life cycle. The NBC, for example, is limited by its scope to addressing durability only at the design and construction phases, and does not deal with maintenance and repair or other factors that can limit deterioration after occupancy.

Durability is defined by CSA S478-95 standard as the ability of a building or any of its components to perform its required functions, in its service environment, over a period of time without unforeseen maintenance or repair costs.

The code deals only with deterioration that affects the health and safety of building users. It does not deal with related costs and disruptions to building use when repairs or maintenance must be performed. The CSA Guideline deals with the durability and premature deterioration issues throughout the life of the building, including the necessary maintenance that has to be anticipated. Explicit in this Guideline are the notions that:

- Durability requires that life expectancy be considered at the design stage;
- Decisions taken during the life of a building will affect performance;
- Beginning with the initial concept, the design process should take into account the environmental loads and forces to which the building will be exposed;

When new types of material are used, or when traditional materials are used in new applications, these factors are even more important.

Basic Durability Requirement

Buildings must be designed and built in such a way that, under foreseeable environmental conditions, they maintain their required performance during their intended life. By design, the predicted service life of buildings and building assemblies should meet or exceed their design service life.

The design service life of a building must be determined at the outset. Typical design service life categories for buildings are given in Table 1.

Table 1

Design Service Life		
Category	**Service Life**	**Examples**
Temporary	Less than 10 years	*Temporary exhibition buildings; sales offices, construction camps*
Medium	25 to 49 years	*Most industrial buildings*
Long life	50 to 99 years	*Most residential buildings; health and education buildings*
Permament	At least 100 years	*"Monumental buildings" (e.g. museums, archives)*

Whether or not the numbers are appropriate may be the subject of another debate, but it does provide a starting point.

While the design service life establishes an overall objective for a building, is important to remember that all components of a building need not have the same design life. For example, we can expect the interior spaces of most buildings to be renovated several times during the building's life, so designers should plan for periodic redecoration. It may be cost effective to set a target life for interior partitions or finishes based on the expected time until redecoration. For commercial buildings, it may be as frequent as every five years. For homes, this is more likely to be every ten years or so, and in some rooms like kitchens or bathrooms, even less frequently.

For a durable building, quality assurance is essential at every stage in the building's life. A fundamental principle of quality assurance is that all persons accept responsibility for their own work.

Durability can be achieved only if:

- there is good quality design;
- good quality materials are used;
- quality workmanship is provided during construction and maintenance; and
- the building is operated within the limits for which it was designed.

Owners, designers, and others involved in the different stages of the building process must also understand the performance objectives.

Building Science Principles

Evaluating the possible deterioration of a specific assembly requires understanding the forces that will contribute to its failure. This requires understanding the microclimate where the building is located, which may differ significantly from published climatic data typically gathered at airport locations.

Failure will not take place just when there is evidence of an agent that causes failure, but when those forces have done their damage. For example, water in a building assembly does not automatically mean failure unless it is present long enough to cause the damage.

Design Considerations

Designs should be based on proven design and construction practices suited to the local climate. This does not mean innovative approaches cannot be used. However, innovative technology must be based on careful analysis or testing to ensure a high chance of success.

Buildings have to operate within the range of temperatures, relative humidity, and pressure differentials for which they are designed. Any variation between operating and design conditions should be controlled within specified tolerances. So if a user sets up a commercial scale tropical plant or marijuana grow operation inside a house, he should not be surprised if mould and fungus damage the structure, since a house is not designed to operate with high tropical temperature and humidity. On the other hand, if the same deterioration occurs in a greenhouse or solarium, it should be considered a failure because the building should have been designed for these conditions.

Materials that come in contact with each other must have compatible physical and chemical properties, and have physical and chemical properties suitable for the environment where they are located.

Ease of Construction

The design for a building and its components has to be buildable. Otherwise, it will not be possible to achieve the required quality. Clear, concise, and complete drawings and specifications have to be provided.

Designs for buildings expected to undergo changes in use and tenancies over their service life should make allowance for future alterations to the contained spaces, the probability of obsolescence of installed services, and the desirability of recycling or reusing components. When undertaking renovation of existing buildings, it is important to take into account the uses (and occupancies) for which the building was originally designed and the uses (and occupancies) for which the design is to be altered. This is becoming more common with the increasing number of old inner city industrial buildings being converted into office, retail and residential use.

Environmental Agents That Can Affect Service Life

Designing for durability implies the need to control or eliminate factors that contribute to failure. These may include environmental, chemical and physical exposures to which materials or assemblies are subjected, and which may result in failure because of the direct action on the materials or thermal expansion.

It is also important to remember that environmental forces act at two levels that can be significantly different. One is the large scale macro-environment. This includes atmospheric and ground pollutants outside the building, and the heating, humidification, and ventilation inside the building. The other is the micro-environment at the surface of, and within, building materials.

Water

Moisture, with or without contaminants, is the most important environmental agent causing premature deterioration. Water is the major contributor to the corrosion of metals, the decay of wood, and the deterioration of other materials, either

Table 2 an example of issues that must be analysed when designing for durability

Design Life and Maintenance							
Element			**Design Life (years)**	**Failure**	**Maintenance**		
					Type	Frequency	Access
Exterior envelope	Foundation		100	cost, safety	*little other than clean drains*		*easy for interior; excavation to repair outside*
	Exterior Walls	*wood siding*	50	cost, appearance	*painting, repair exterior*	*4-8 years for repainting*	*easy for exterior finishes*
		sheathing paper on plywood	50	safety, cost	*none*		*removal for materials within envelope*
		Batt insulation	50	cost, disruption	*none*		*removal*
		gyp board interior		disruption	*little*		*easy from interior*
	Roof	*shingles*	10 - 25	safety, health	*none*		*removal*
		membrane	15 - 20		*none*		*removal*
	Windows & doors	*double or triple glazing*	20 - 30	health, security, appearance	*caulking, weatherstripping replacement*	*depends on materials*	*replacement of sealed units*
	Exterior Doors	*Metal insulated*	50	security, appearance	*repair, repaint*	*as required*	*easy*
Exterior junctions	Flashings		20	cost, safety	*significant*	*15 - 20 years or as required*	*easy to difficult depending on details*
	Sealants		2 - 5		*extensive*	*annual inspection*	*may require ladders*
Interior	Walls	*gypsum board*	50	disruption	*little*	*as required*	*easy*
Floor structure	Plywood subfloor		100	safety	*little*	*as required*	*remove finished flooring*
	floor joists		100	safety	*little*		*removal*
Floor finishes	Carpet		10 - 15	appearance	*significant*	*weekly*	*easy*
	Hardwood		20 - 30	appearance	*significant*	*as required*	*sanding, refinishing. or replacement*
	Vinyl		10 - 15	appearance	*significant*	*as required*	*removal*

directly or a means of transport of other agents. Water in the atmosphere, in its various states (gas, liquid, or solid), interacts with material surfaces in several forms as moisture taken up by a material (adsorbed moisture), as condensed water, and as precipitation.

Most organic and many inorganic materials are porous and absorb moisture. Organic materials, such as wood, will also decay when exposed to excessive moisture in the presence of oxygen and fungi. Water can move contaminants into the structure that can deteriorate materials. Damage also happens because water causes materials to swell, and destroys their cell structure when it freezes.

Air

Atmospheric oxygen is corrosive, especially when present with moisture.

Air Contaminants

These are contaminants largely generated by human activity. The major air pollutants that cause deterioration problems are salts and oxides of nitrogen and sulphur. They dissolve in rain, so that precipitation becomes acidified. As this washes over buildings, it literally melts the buildings away.

The most dramatic effects can be seen in Europe, where urban and industrial pollution is destroying buildings that have survived for hundreds or thousands of years. Greek and Roman antiquities are suddenly losing much of their detail. In Central Europe, fine architectural examples that have survived Europe's ruinous wars are simply crumbling, as acid rain (a result of industrial pollution) washes over them. Even in Canada, our much younger heritage buildings that have survived development pressures and urban renewal are losing their character and charm.

Soils and Ground Contaminants

Not all offending contaminants are man made. Naturally occurring constituents in the soil may promote the deterioration of building materials.

Biological Agents

Buildings can literally be eaten away by living organisms. These are not creatures out of science fiction, but simple bacteria and insects that attack organic materials. Given the opportunity, even plants can harm buildings.

Temperature

All materials exposed to temperature variation are subject to thermal stresses that contribute to failure. Especially roofing systems and cladding components are subjected to high temperatures in summer and very cold temperatures in winter and must expand and contract as the temperature cycles. In some locations, at sometimes of the year, the surface temperature swing can approach 100°C each day. Such thermal stresses alone can deteriorate building components.

Solar Radiation

Ultra violet radiation is a powerful force. Organic materials such as polymers and wood deteriorate when exposed to solar radiation.

Chemical Incompatibility

Materials in contact with each other may cause or accelerate deterioration because of chemical reactions. Dissimilar metals placed together may lead to galvanic corrosion. Similarly, some finishing or preservative materials or natural wood chemicals can accelerate corrosion of metal fasteners or flashings.

Environmental Parameters

Considering environmental factors, is not just a matter of taking the contaminants themselves into account. It is also a matter of considering the risks the contaminants present. For example, short term water exposure in itself may not be a problem. However, the longer the materials remain wet, the more likely that deterioration will set in.

The Driving Rain Index

Wind driven rain is an important factor for wetting walls. If there is no wind, walls do not get wet. The driving rain index is a tool that provides an indication of the kind of exposure to moisture that can be expected. In many locations, wind driven rain may not be critical. However, a lot with a spectacular wind swept view overlooking the ocean can be expected to have a high driving rain exposure.

The CSA standard includes an Appendix that summarizes the many forces that help destroy building materials, the conditions when deterioration will proceed, and strategies to avoid problems. ☼

CSA S478-95 Guideline on Durability in Buildings
Information:
Canadian Standards Association
Tel: (416) 747-4000
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Fax: (416) 747-4149
E-mail: info@csa-international.org
www.csa-intl.org

Letters to the Editor

Re: Construction Practices for Engineered Wood I-Joist Floors (Solplan Review No. 91, March 2000)

Could you please confirm if there is an error in the article under the subheading Bearing Loads?

It would seem to us that the squash blocks should be 3mm (⅛") longer than the depth of the I-joist to avoid the joist taking the load from above.

We enjoy the Solplan Review articles and often use them as support material to bring important construction details to the attention of our field staff.

W. Byron Scott
Monarch Construction Limited
Toronto

Please note that the description of the length of a squash block is not correct. Instead of being shorter than the joist, it should be 1/16" deeper than the joist to ensure that loads a re transferred via the squash block.

Andy Teasell, P.Eng.
TrusJoist

Editor's response follows:

Oops!

Engineered Wood I-Joist Floor Assemblies

Despite the best intentions, sometimes things can go wrong. Last issue we had a piece on construction practices for engineered wood I-joist floors. The piece was meant to raise attention to the need to follow proper installation practices. Unfortunately, an error found its way into the final text that went to the printer, as several readers were quick to spot. As a result, the story may have created more confusion. (And no, we can't blame it on a computer virus). So we are reprinting the correct text here.

This also provides the opportunity to highlight important terminology and how these elements are used.

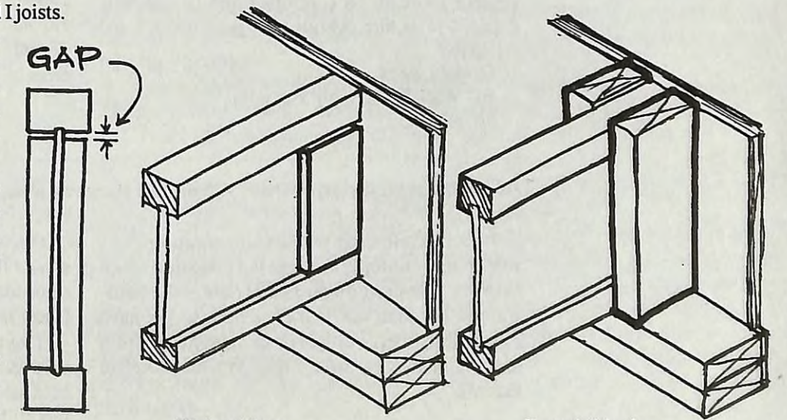
There are two conditions where additional stiffening and support may be needed for wood I joists.

What must be established for a specific design and location is where they are to be used. *Web stiffeners* are blocks of wood that fit between the flanges, and provide added support for point loads on the I-joists, usually (but not only) at mid-span. *Squash blocks* are wood blocks that are used to transfer loads across the floor joists to a lower support. They are not installed between the flanges, but rather on either face of the joist.

Bearing loads

When needed, squash blocks can be used to transfer loads from above and through the I-joists. Squash blocks should generally 3 mm (⅛-inch) longer than the I-joist depth to ensure the load does not get applied to the top of the joist. The blocks are short lumber stubs that fit against the side of the flanges through which the load is transferred. At interior supports, overlapping the wood I's sometimes provides enough contact area and bearing capacity. But this must be checked to make sure that the load bearing capacity is sufficient.

Web stiffeners and squash blocks are not normally pre-installed. They must be installed on site when the exact support locations are known. If left out for later installation, squash blocks can be difficult to insert, and make the structure unstable while they are being installed. ☼



Web stiffener. *Squash block*
Nailing pattern as specified by manufacturer

Letters to the Editor

Re: Leaky Houses (Solplan Review No. 92, Mar 2000)

Maybe I'm too sensitive, but the article is just one more piece of narrow thinking that takes issue with the cladding material when a detail fails. While there has been a recent evolution in the thinking and the term "face-sealed" is on everyone's lips, one is hard pressed to find examples of marketing that promoted any cladding system that would provide "waterproofing" for bad details. Why is it never the fact that if the details had not failed, the wall would likely have survived nicely, thank you very much? But when a detail fails for whatever reason, it is the stucco or EIFS (exterior insulated finish) cladding that takes the public and media thrashing.

As a case in point, several years ago there was a major wall collapse in Burnaby, where a huge section of an EIFS wall fell off during the night. Despite the installing contractor's protests that the flashing details were inadequate, the work was pushed ahead and it failed. During the litigation that took place as a result, the flashing details were found to be the sole cause of the failure. The EIFS assembly was replaced in exactly the same design, with substantial changes to the flashing details and is working as originally designed to this day. Nevertheless we still have public officials and others claiming that "AH-HAA!, there is an EIFS failure for you."

It is a sad testament to our construction industry that we cannot think past bumper sticker explanations for building envelope problems. But then "It's Face Sealed, It'll Fail" fits much more easily on a 100-mm x 300-mm sticker than "Flashing, connections, transitions, penetrations, windows, decks, balconies, railings, and interior moisture sources must all be controlled and be carefully detailed to ensure overall wall performance and integrity."

Gregg Lowes
BC Wall & Ceiling Association
Surrey, BC

Your criticism is fair. The stucco industry unfortunately has been taking the flack for all the ills that have befallen the industry on the West Coast. We were not trying to blame the EIFS. Our point was to show that the application details are important, and the consequences can be devastating on projects of any size. While multi-family projects have received much media attention, many of the same mistakes with the same consequences have happened to single family homes.

It is interesting to note that so far nobody has commented on the fact that a large number of houses in rainy, windy Northern Europe are clad with stucco with no major moisture problems.

In order to perform, any material must be used appropriately, and installed correctly. The cladding was mentioned because EIFS was used on the house described, and there was a lingering perception that EIFS (as well as conventional stucco) was a waterproof material. Sales people did make a point to show how water resistant (or waterproof) their products were. I recall a pavilion at Expo 86 in Vancouver even had a sloping wall (effectively acting as a roof surface) finished with EIFS. No doubt, it would have been built with careful attention to detail with a membrane beneath it, but technical details are not visible, and do not help define perceptions.

As we know, even the best waterproof roofing membrane will not keep the water out if it is installed incorrectly. We agree with you that flashings, connection details, transitions, penetrations, windows, decks, railings and interior moisture sources must all be controlled and be carefully detailed to ensure overall wall performance and integrity. Ed.

Re: European Exterior Doors (Solplan Review, Mar. 2000)

I read with interest your comments about exterior doors in Europe. I believe the main difference between European products and ours is the hardware rather than the door edge design. We have successfully used a single or blunt system with a multipoint lock for over a decade with complete success.

Our CSA testing on two window types has shown that a single, quality weather strip will, in some cases (e.g, water penetration) give much better results than two.

There seem to be two main reasons why this hardware is so effective. First, the door panel is held against the weatherstrip in several places rather than in just one, eliminating deflection and warp. Secondly, the structural edge of the door, its weakest part, is only drilled out a fraction as much with a European multi-point lock system compared with standard North American locks.

Because the hardware makes the door many times stronger, a much smaller style can be used, allowing a larger glass area relative to rough opening. Today's trend toward taller and wider doors makes this hardware even more necessary.

I really enjoy Solplan Review - keep up the good work!

Keith Washington,
KW Doors & Windows
Mill Bay, BC

I agree with you about the different hardware, which in many respects is superior. However, I was referring more to the door slab design itself. The European rabetted-edge door is commonly used both for interior and exterior applications. Its design makes it easier to achieve an airtight closure. This is especially of interest in multi-family dwellings, where smoke and acoustic separation between units are desirable, and even within dwellings to maintain privacy.

Such a design does require rethinking how ventilation air is distributed. Our approach generally is to pressurize the hallway and allow undercut doors to be the path for fresh air into the apartment. While this may do the job, and keeps odours confined to each unit, it does nothing for privacy or smoke control.

I have often been troubled by hallway light and late night partygoers while staying in some of the best hotels in Canada - because of the undercut doors that offer little acoustic privacy, but are meant to provide fresh air from the corridor. This also applies to most apartments.

I have observed a similar situation in many single family dwellings. When you can see daylight around the edges of an outside door, you know it is not airtight. The square edged door design we use may make the door inexpensive and easy to handle, but it does make it more difficult to achieve good air seals. That is why a whole industry has evolved around manufacturing astragal weather stripping systems for exterior doors. Ed.

You Asked Us:

About Heat Recovery Ventilators, Heat Pumps and Home Design

I have a concern about HRVs because of the ineffective filter they use and the negligible maintenance done on it. That presents limitations about air quality in a city context, where outdoor air can be very dirty. Using a heat pump is kind of idiot proof - a large electrostatic micro particle filter can be used - when it is dirty you throw it out. Very visible, very easy to change.

In addition, HRVs are inevitably installed with flexible ducting and with few outlets. Many of these ducts run through the attic where I find they have been crushed. The flex ducts compress easily if someone inadvertently steps on them, or if fiberglass batts are pushed down over them, which is all too common. Heat pumps installed by mechanical contractors necessarily involve rigid, permanent, metal ducts (for the most part) which hold up well over time.

Using trees to shade windows or overhangs to reduce overheating is a non-issue (insulation, airtightness, thermal masses, fans - all of that is taken for granted). Just visit the new suburban developments; there are no mature trees and if there are, they are rarely at the front or sides of the house - usually at the back of the property. One does not see any overhangs either. It is just not in vogue right now and houses are exposed to direct sunlight.

People's expectations have changed. Most drive air-conditioned cars, work in air-conditioned offices, and their kids go to air-conditioned schools. When they come home after work or school, they will not put up with hot muggy homes. The microclimate in the city is very different from the country. It is very revealing to see houses with HRVs and occupants that have added portable air-conditioning units in windows. This speaks for itself.

The problem also might be the poor quality of the mechanical installations, be they HRVs, heat pumps or furnaces. I have seen oil furnaces installed with heat pumps that do not operate jointly; with two separate thermostats - one for heating, one for cooling; HRVs that are simply turned off because of the confusion over understanding their limitations - the unit's inability to dehumidify or humidify during inclement weather, etc. Furnaces and air conditioners are often oversized to make up for the high winter heat loss at the clear glass windows and the radiant heat loss from the roof and windows. I wonder if anyone has done a proper heat gain/heat loss calculation to determine the required heating capacity?

In addition, the problem with heat pumps is the outdoor noise created by the compressor/condenser, which can be disturbing. Hopefully this will improve in due course as the technology is changing very fast. MC, Montreal

You raise several common issues. However, you are confusing the function of a heat recovery ventilator (HRV) and a heat pump.

A heat pump provides HEAT and COOLING, while the HRV provides VENTILATION air. It is important to remember that the HRV does not provide heat or cooling. The air flows are significantly different. Yes, outdoor air can be dirty, but it is still generally cleaner than indoor air (unless, of course, the intake is at ground level, immediately on a major thoroughfare with no setback). It does require some maintenance, but most people, made aware of the system, do become sensitized and realize something is wrong when the filters get plugged.

Of course, this means that the HRV must be placed where it is accessible for easy

maintenance. I have seen installations where the HRV is completely inaccessible - for instance in a corner of an attic, or in a 2-foot crawlspace far away from an access hatch. In these cases, the HRV obviously will not be serviced, and indoor air quality will suffer.

If an HRV is installed the way you describe, it is a substandard installation that is not in accordance with code or installation standards. Flex type ducting should never be used as the main duct runs, and placement of ducts in the attic should always be avoided. HRVs should only be installed by competent mechanical contractors - this is not a do-it-yourself job. If you have seen such installations on your jobs that should be grounds for rejecting the installation.

Poor architectural design is poor design. It may be happening, but that is not an excuse for ignoring good design practice - which includes siting and landscaping. The current fashion of no overhangs is no excuse for taking them off It is not good design to avoid overhangs in many cases because overhangs can eliminate other problems. It is necessary for us to encourage the use of overhangs where appropriate.

There is a standard for sizing heating and cooling systems which is referenced in the National Building code. Mechanical trades are starting to do heat loss calculations. In some BC municipalities, separate heating system permits are required. These call for heat loss calculations and heating system layouts before a permit can be issued. Utilities are also getting behind such programs. Enbridge for one, has a program.

As for heat pump compressor noise, it is important to remember that there are quiet units on the market. Noisy compressors may be a matter of cost or lack of maintenance. You get what you pay for - good system design and installation require competent personnel, and cannot be done by a tailgate contractor working on piecework. Regular maintenance also reduces noise, as do proper location and screening.

Wood Moisture: the Effect of Floor Concrete Topping

Increasingly, we are seeing concrete or gypsum cement topping in frame construction. It is used in the increased number of floor radiant heating systems, and for fire and sound separation in homes and in multi-family buildings. For radiant heating systems, the thermal mass provided by the concrete is an essential element of the heating system. But as we know, concrete contains a large quantity of water. Applied directly on and next to wood, concrete is a source of water loading.

Vancouver architect and building envelope professional Brian Palmquist of Pro Pacific Architecture was troubled about the water loading that such a topping represents, especially at the sill plates - which are usually double plates. The bottom plate is used as a pouring guide for the 1 ½" light weight concrete, and the upper plate is the backing for wall finishes. Brian took moisture readings at several locations on both interior and exterior walls, both before the concrete topping was poured, and three days after.

He selected three days because that is often when insulation and poly vapour barrier work starts. The exterior walls included a 6-mil poly strip running about 12" onto the plywood deck, to be wrapped up the inside of the wall, thus creating a barrier to moisture movement between concrete and sill plate.

The results showed that the moisture content of the lower sill plates that were not protected with poly increased on average 7% above the starting point. At some points, the plates had a moisture content level greater than 19%. However, the moisture content of the plate protected by the poly increased an average of only 3%. In other words, the unprotected plates can absorb more free water from the concrete topping than the protected plates.

It is important to remember that builders want to insulate, poly and drywall as soon as possible, and do so when sample readings show that the wood has the "magic" 19% moisture content identified by the building code. However, we now know that a surface moisture content of 19% does not mean that the centre of the wood is also at 19%. The moisture content actually is much higher, and the wood dries out slowly. By enclosing the wood too quickly, the moisture may actually be trapped within the construction, providing all the lunch ingredients for wood-rotting critters. Indeed, there is anecdotal evidence to suggest that there may be wood deterioration taking place in such locations because of internal moisture being trapped in the construction, with a vapour barrier on both sides of the plate (the interior poly and the exterior OSB or plywood).

One possible action to reduce the potential of trapping moisture is to apply poly on all plates when concrete topping is going to be used. This protects the plates from the excess free water in the concrete.

The Cost of Climate Change

Half of all property losses in the last 40 years have happened since 1990... and 21 of the 24 largest insured weather-related disasters have happened in the last 10 years!

Greenhouse gases are building up in the atmosphere because of human activity, including how we use energy. The greenhouse gases we pump into the air are changing the natural balance that has existed in the atmosphere for thousands of years and is causing the Earth to heat up.

For many Canadians, warmer temperatures might not seem like such a bad idea. However, the concentration of greenhouse gases in the atmosphere is rising at an unprecedented rate. Today, concentrations of carbon dioxide are 30% above pre-industrial levels, just two hundred years ago. Half this increase has occurred only in the past 30 years!

As a result of these changes, the average global temperature is expected to rise by 1 to 3.5° C over the next century. However, because of variations over the surface of the earth, the increase in annual mean temperatures in some parts of Canada may be as much as 10° C over the next century. As a northern country, Canada's ecosystems are vulnerable to this kind of change.

To reduce the devastating consequences of climate change, at the Kyoto conference Canada agreed to cut greenhouse gas emissions to 6% below 1990 levels by 2012. This is less than the 60 to 80% reduction scientists argue is necessary, but it is an important first step. While some countries have started to reduce emissions, Canadian emissions are still increasing by 1.5% annually. Today, emissions are close to 10% above 1990 levels. We are now the second highest per capita producer of greenhouse gases and the highest per capita consumer of energy in the world.

Why Should We Be Concerned?

Increased cases of extreme weather events are projected. This means more severe droughts, winter storms and tornadoes; flooding and erosion in coastal regions; forests fires; damage to water resources and everyone's health and well-being. Rising water levels will lead to the disappearance of entire islands and island nations. While this all seems to be gloom and doom, to be able to deal with the problem, we have to understand the nature of the problem.

Natural catastrophes are already part of everyday life. They affect every region of the world, and are increasing in frequency and severity. The result is significant property damage and economic loss.

Unfortunately, there is still much denial over this issue. Even when we acknowledge the problem, we have difficulty taking action. However, all sectors of society must improve energy use. Because most of the greenhouse gases are generated when oil, coal, gasoline, and natural gas are burned, the only way to significantly reduce emissions is to use less of these fuels. We are all part of the problem, and we can all be part of the solution.

Cutting the use of fossil fuels will reduce the air pollution that currently accounts for up to 16,000 premature deaths each year, along with billions of dollars in health care costs.

The insurance industry is already facing financial risks because of natural disasters. Half of all property losses over the last 40 years have occurred since 1990, and 21 of the 24 largest insured weather-related disasters have happened in the last ten years. Insurers are paying more attention to climatological reports, and are encouraging pro active action to reduce energy use. Insurance companies could react by raising deductibles or withdrawing coverage.

Here are some pro-active actions the insurance industry has already taken:

- The Insurance Institute for Property Loss Reduction has endorsed the enforcement of building energy codes.
- The Zurich-American Insurance Group offers specialized insurance policies for third party energy service companies that use energy efficiency technologies.
- Three European insurance companies have joined in a project to use the purchasing power of building owners to create markets for energy efficient copiers.
- The Pacific Gas and Electric Company - one of the largest utilities in the USA - has formed an alliance with the insurance industry to encourage efficient energy use by customers. The goal is to have every energy project considered for its risk management benefits.
- The Oak Ridge National Laboratory has entered into a co-operative research and development agreement with the Roofing Industry

Committee on Wind Issues, which includes all major roofing trade associations in the US and various insurance partners. The project will investigate energy efficient ways of making roofs more resistant to damage during windstorms.

Global climate concerns aside, any measure that decreases insurance losses contributes to the bottom line of both insurers and insured. By supporting energy efficiency, the insurance industry reduces short-term business risks caused by payouts that exceed premium revenues, while making a considerable contribution to reductions in greenhouse-gas emissions that also threaten revenue.

Reducing Energy Use Improves Air Quality

Air pollution is a serious threat to our health and environment. Most air pollution is caused by the fossil fuels we burn in our vehicles, homes, thermal power plants and factories. Increased use of vehicles, higher energy consumption and more vigorous economic activity all contribute to air pollution. New research shows there may be no safe levels of exposure to some air pollutants.

The major air quality pollutants are nitrogen oxides (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter (PM) and volatile organic compounds (VOCs). When some of these combine, they produce smog or acid rain.

Much of the smog in our cities is generated locally. Ground-level ozone, the major component of smog, is formed when NO_x and VOCs react in the presence of warm temperatures and sunlight.

Acid rain is caused by pollutants such as sulphur dioxide and nitrogen oxides, which are absorbed by rain drops which become acidic. Dilute forms of these acids fall to earth as rain, hail, drizzle, freezing rain or snow, or are deposited as acid gas or dust.

Changes in soil chemistry caused by acid rain may be responsible for a decline in soil nutrients in particular forest ecosystems, resulting in a slower growth rate and increased death rate in trees.

Any actions we take to reduce energy consumption will have a positive effect on reducing urban air pollution. This means building the most energy efficient buildings possible, encouraging energy efficient retrofits, and also using more energy efficient vehicles and equipment.

R-2000

For information on the R-2000 Program, contact your local program office, or call 1-800-387-2000

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Household Greenhouse Gas Emissions

The climate is undergoing changes, linked at least in part to human activities that release greenhouse gases. The principal greenhouse gas is carbon dioxide (CO_2), released when we burn fossil fuels such as oil, natural gas, coal or gasoline. Even electricity, which we think of as "clean energy", is often generated by burning fossil fuels. Another important greenhouse gas is methane (NH_4), which is produced by the decomposition of organic materials (like paper or food waste) in landfills.

We may feel helpless do to anything about reducing greenhouse gas emissions. However, our lifestyle choices are important, because our choice of cars, home appliances and how we use them, account for about one third of the total greenhouse gases produced in Canada each year.

The questionnaire below is aimed at helping assess how a household fares in terms of its greenhouse gas emissions, and where changes can be made. It was developed by CMHC, and is based on average values of greenhouse gas production and its embodied energy.

Use the ***Greenhouse Gas Emissions Calculator*** to find out how your household stacks up. Fill out the questionnaire and total your score.

A typical Canadian household of two adults and two children in a 2,500 sq. ft. house with one car would have a score of about 27,650 kg/yr on this questionnaire. This should give you some idea as to whether your household's emissions are high or low compared to the average.

Canada's Kyoto commitment calls for a six percent reduction of emissions by 2012. To ward off global climate changes, we may have to reduce emissions 60 percent below 1990 levels.

Personal energy reductions will depend on individual circumstances and the willingness to make large and small changes to lifestyles and living conditions.

Reducing emissions is not all pain and sacrifice. It can also have many benefits. The ***Greenhouse Gas Emissions Reductions Calculator*** (page 14) has some suggested actions to take in each category, along with the savings that can be achieved.

As a builder, you can directly influence the operating energy use and embodied energy in the house construction. As you can see, these can be significant. Another reason to stress energy efficiency and R-2000 construction.

Greenhouse Gas Emissions Calculator

To find out how you stack up, fill out the questionnaire below and total up your score. To use this table, in the left column enter the total applicable, multiply by the factor provided to get the annual total of greenhouse gases per year. Add the totals in the right column to get the annual total greenhouse gases from all sources generated by the household.

Operating energy: space heating and services
Greenhouse gases (GHG) emitted from your home due to energy use can be calculated from utility bills.

energy use	factor	annual GHG
average monthly electrical consumption (kWh) e.g. 3,500 kwh	6	kg/yr 21,000. kg
average monthly natural gas use (cubic metres)	28.62	kg/yr
average monthly oil use (litres)	38.16	kg/yr

Transportation

Annual emissions generated in transportation can be estimated if you know the fuel efficiency of your vehicle and the approximate distance driven per year. Fuel efficiency is expressed by number of litres used per 100 km traveled. Typical fuel consumption is:

full-size pick-up, full-size SUV:" 18
full-sized car, mini-pick-up, small SUV, or minivan: 16
mid-sized car: 11
small car: 9

fuel efficiency	(km driven)	0.025	kg/yr

Public transit use also generates emissions, and should be considered. (Totals per household)

Average distance travelled on public transit km/week	2.3	kg/yr
Average distance travelled on train or inter-city bus km/year	0.15	kg/yr
Average distance travelled by plane km/year	0.25	kg/yr

Lifestyle

Waste How many green garbage bags or small garbage does the household put out per week? (e.g., if you put out 1 bag every two weeks, enter 0.5).

# bags or cans	300	kg/yr

Food

Food-related emissions depend on diet (whether the household is mostly vegetarian or not).

# of vegetarian people	50	kg/yr
# non-vegetarian people	504	kg/yr

Food-related emissions also depend on whether an effort is made to buy locally produced food (within 500 km). Enter 0.085 as a distance factor if an effort is made and 0.256 if not.

# in house	distance factor	872.9	kg/yr

Embodied Energy

House Construction Energy was used to create the materials that went into building the dwelling. The larger the building, the greater the greenhouse gas emissions involved. This is an approximate value for a typical house, per square foot, including basement. The embodied energy of an older home (at least ten years old) can be discounted by 25%. (Enter .75 as a discount in the equation).

sq. ft.	discount factor	0.57	kg/yr

Transportation Vehicles consume energy during their manufacture, so their embodied energy also has to be accounted for. The approximate embodied energy factor for typical vehicles is:

full-size pick-up, full-size SUV: 725
full-sized car, mini-pick-up, small SUV, or minivan: 678
mid-sized car: 608
small car: 524

the embodied energy of an older vehicle can be discounted by 25%. (Enter .75 as a discount in the equation).

vehicle type	discount factor	kg/yr

GHG Produced when Heating a Home

So how many greenhouse gases does a typical house generate? Recently I did calculations for two new houses in the Vancouver area. These are typical upscale homes. The numbers refer to the gases generated only by the energy used for space heating. Energy use for hot water and other appliances would add to the total.

One is a 2,500 sq.ft. waterfront house with very large glass areas. If built to current building code requirements and heated with natural gas, it would generate about 8,037 kg/yr, but if built to R-2000 standards, this drops to around 3,000 kg/yr (or a total saving of more than 5,000 kg/yr).

The second house, presently under construction in the Abbotsford area, is 3,700 sq.ft. If built to code standards and heated with natural gas it would generate 6,077 kg/yr. This drops to 2,653 kg/yr when built to R-2000 standards (or a total saving of more than 3,400 kg/yr).

The gasses are invisible. These numbers may seem small and hard to appreciate. But cumulatively, the totals add up.

Greenhouse Gas Emissions Reductions Calculator

This calculator offers suggested actions that can be taken, and the impact they will have on total greenhouse gas production.

Action	Associated Benefits	How to Calculate your Potential Reduction	Amount to Place on Your Reduction List
Home Energy (Operating and embodied)			
Switch from electric to gas heating	*Reduce electromagnetic fields in your home*	1.63 kg/yr for each sq.ft. of house size	
Switch from electric to gas hot water	*Reduce energy bills*	156 kg/yr for each person in household	
Choose a smaller home	*Reduced mortgage payments*	6.5 kg/yr for each sq.ft. reduction in house size	
Install energy-efficient lighting	*Save on electricity bill*	225 kg/yr for each frequently used light bulb	
Replace average efficiency appliances with the highest -efficiency models	*Save on electricity bill*	60 kg/year for fridge 34 kg/yr for stove 115 kg/yr for dishwasher 176 kg/yr for clothes washer 31 kg/yr for clothes dryer	
Wash clothes with cold water	*Save on energy bill*	112 kg/yr for each load per week	
Turn down your thermostat	*Sleep better and save on heating bills*	112 kg/yr for each degree C reduction	
Stop using air conditioner	*Save on electricity bill*	0.8 kg/yr for each sq.ft of house size	
Transportation			
Drive less by moving closer to work or by taking transit, biking or walking	*Improve fitness and reduce air pollution*	Take amount of reduced car travel in km, and multiply by the fuel efficiency factor for vehicle	
Choose a smaller, more fuel-efficient vehicle.	*Save money and reduce air pollution.*	Difference in embodied and operating energy between the automobiles	
Use transit less as biking and walking increases	*Save money and get fit*	0.044 kg/yr for each km less travelled on local transit	
Reduce air travel	*Combine business and vacation travel*	0.25 kg/yr for each km avoided	
Lifestyle			
Reduce garbage by buying fewer products and avoiding packaging	*Save money*	300 kg/yr for each weekly bag of garbage	
Reduce garbage by composting and recycling	*Use compost on your vegetable garden*	300 kg/yr for each weekly bag garbage	
Food			
Switch to meatless diet	*Maintain better health*	450 kg/yr for each person in household	
Buy locally produced food when in season	*Obtain better- quality foods and support local farmers*	Estimate the % of total food purchased locally x 223.5 kg/yr	
Total Reduction From These Actions			

Technical Research Committee News

Objective-based Codes

As we have reported in the past, the National Building Code is being reviewed and rewritten into an objective-based format. This means the focus will be on the basic objectives of the code, rather than detailed how-to prescriptive requirements. Although the actual requirements will not really change, how they are stated will be done differently, allowing more opportunity for creativity and innovation in the building process. However, this will mean that the way we look at codes will also be substantially different. The change may lead to angst for a while until the industry gets used to a new format for code documents.

The first and major step of the review process has been completed. The analysis of current code requirements has identified the following as the key code objectives:

Safety: fire, structural, and in use.

Health: indoor environment for users, sanitation, and containment of hazardous liquids.

Accessibility

Protection of the building: from structural insufficiency, from fire in adjacent buildings

A document for public review will be ready for comment later this year. It is important that anyone interested in the code look at the proposed changes, and make their comments known. If you have a concern, this is a "heads-up" notice to be ready to review the material when it is available.

Because of the new code development process accepted by all provinces, comments or changes can be made either to the Canadian Codes Centre or through your provincial codes authorities. The review will be done through a coordinated effort at both a national and a provincial level.

Mechanical Ventilation

Residential ventilation systems must comply with CSA F326, the Residential Mechanical Ventilation standard, which is what every R-2000 home must have. Because of the complexity of the standard's language, the building code was written with a simplified prescriptive language that, it was hoped, would be easier to follow on the job site. However, that has not proven to be the case.

How to comply with the ventilation requirements is still a major issue for many builders and regulatory authorities. Most builders want to avoid one option that would satisfy the requirements – namely, using heat recovery ventilators and not using spillage susceptible combustion appliances.

The best response for a specific area may well be different across the country, depending on local construction practices and mechanical systems used.

Draft revised language for a prescriptive option for compliance with section 9.32 of the NBC has now been prepared. However, before it is released, the proposed revisions will be tested in the field to ensure they are practical, achievable, and functional.

At this time, is appears that new code language will not be available until early next year. Meanwhile, interim information of help to builders on practical, acceptable ventilation system approaches will be distributed when available.

We will keep readers posted.

Air leakage from attached garages

Studies have shown that there is a considerable amount of air leakage through the common wall between an attached garage and the house. One indicator of the leakage through the common elements is the fact that when a carbon monoxide sensor is installed in the house it can be triggered when a car is started cold.

Final results of a Health Canada study are not yet available, but there is enough preliminary information to suggest that attached garages are a concern, and that we need to give more attention to how details in the common elements are handled. As R-2000 builders know, it is not just a matter of having a well-weatherstripped garage door.

Besides better air sealing between the garage and the house, one possible remedial step that has been suggested is to install an exhaust fan with a timer set to run whenever the garage door is opened.

Canadian Home Builders' Association

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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Energy Answers

How do you build a building in a wet climate that will not leak water? The evidence to date shows that the problem is water entry from outside. Interior moisture sources are not generally the problem. It may be, however, that interior moisture sources are contributing to the problem, but the greater problem is exterior water sources.

Rob Dumont

Your recent piece about commercial building air tightness was interesting and timely. As you are aware, BC is suffering from a building failure crisis of previously unknown proportions. Commercial and public buildings have recently been identified as real and potential problems. In my view commercial buildings do not come close to approaching Code standards for air leakage.

Recently, some public buildings in coastal BC have come under scrutiny. Major deterioration has taken place in the exterior gypsum sheathing. Because these buildings have stucco cladding, the premature conclusion is that the stucco must be allowing the water to go into the middle of the wall! However, I think many other things are happening that need to be examined before concluding that failure is due to water permeating through stucco.

A typical assembly is: interior gypsum sheathing, poly vapour barrier, structural steel columns, 6" to 8" infill steel framing, batt insulation, exterior gypsum sheathing, housewrap and three-coat stucco with acrylic finish. This is an "economy" wall assembly that is used widely in schools, hotels, commercial buildings and multi-family buildings. Very little attention is given to air leakage, and where it has, it was poorly done at best.

I contend that the assembly as described is severely compromised by the inadequate thermal performance and the significant air leakage. In a school situation where up to 1,000 people are giving off a litre or more of moisture per day, there is a significant movement of warm moist interior air into the stud cavities that, at their exterior face, are well below dew point. This leads to a large deposition of condensation on the inside face of the sheathing leading to saturation and ultimate failure of the gypsum sheathing.

Based on your comments in Solplan Review it leads me to think that my theory is well founded. Am I correct on this or are there some real issues that are being overlooked by our consultants' myopic focus on stucco acting as a water filter?

Gregg Lowes,
BC Wall & Ceiling Association

Readers with questions can contact Rob Dumont at robdumont@hotmail.com

Here are a few principles to keep in mind for designing walls that don't get wet, FROM EITHER THE OUTSIDE OR THE INSIDE.

1. Keep the rain water from falling on the wall in the first place.

Most houses in Canada have roof overhangs that do a good job at keeping the rain off the exterior walls. The overhangs don't work perfectly, since wind-driven rain can still strike the building walls, and on taller buildings roof overhangs don't make much of a difference at the lower levels of the walls. Generally, roof overhangs work quite well on low-rise buildings. The "Survey of Building Envelopes Failures in the Coastal Climate of British Columbia" showed that 88% of all buildings with no roof overhang had wall moisture problems. Only 25% of buildings with roof overhangs greater than 600 mm (2 feet) had moisture problems. Roof overhangs work!

One could build a multi-storey building with roof overhangs at each floor level. These overhangs, besides keeping the water off the walls, can serve as sun shades to reduce the direct solar gain on the windows facing east, south and west.

2. Take it for granted that a perfect face-seal on the outside of the building is impossible. Even welded steel ships have a bilge pump!

Any type of exterior wall finish – be it stucco, acrylic stucco, wood, steel or vinyl siding, plywood, precast concrete panels, precast fiberglass, brick, or stone – will leak. If you don't think they will leak in a wind-driven rain, I have some ocean-front property for sale for you here in Saskatchewan.

A better way to visualize how the outer face of the building will leak is to consider what would happen if the wall were placed on the horizontal with an inch (25 mm) of water placed on top. One inch of water pressure is roughly equivalent to the wind pressure present during wind storms.

All the walls mentioned above will leak. If the material itself doesn't leak, the joints will. Every building has windows, doors, electrical, plumbing and telecommunication lines and flashings that penetrate the exterior walls. They can all leak as well.

3. A drainage plane behind the outer cladding of the building is desirable.

Since water always leaks through the outer cladding of the building, there has to be some way for that water to leak out or dry out before it can seriously damage moisture sensitive materials in the wall assembly. Exterior gypsum board is moisture resistant, but given enough time and moisture it will deteriorate.

The drainage plane is part of a rain-screen design. Air spaces 50 to 75 mm wide are recommended (but no less than 19 mm), and they require proper flashings to direct the water back out to the face of the building. Compartmented air spaces work even better.

4. Building papers leak.

Building papers leak either through the nail or staple holes, or at the edges of the building paper. Make a cup by folding any building paper. Most will hold water. Put a staple below the water level, and the water will readily leak through.

Some building papers are also prone to leaking through the paper if a surfactant such as detergent touches the paper. You can test for this by putting a drop or two of dishwashing liquid in a water-filled cup made from building paper. Many building papers will leak in the presence of a detergent. Many stucco installers use detergent to improve the workability of the stucco mix. Detergents and other surfactants are a no-no with many building papers.

Some building paper manufacturers are now recommending that an air space be placed outside the paper to reduce rain leakage. The CCMC product evaluation for several building papers state "as recommended by the manufacturer, install(ed) with a minimum 10-mm air space between the sheathing membrane and the cladding, unless the cladding has been deemed to not require an air space (e.g., deemed by CCMC or deemed by building officials based on past cladding performance).

5. Shingle the building paper.

This is obvious, but I have seen some buildings where the building paper is installed from the top of the wall down. It is difficult to shingle the building paper to shed water when the paper is installed from the top down. The overlaps must shed water, and not direct the water into the wall.

6. Air tightness of the wall assembly counts.

"If it's airtight, it's water-tight."

It is the airtightness of the wall assembly that will determine if water can reach the interior. Water needs a hole and a pressure difference (gravity, wind pressure, stack effect or capillary pressure) to enter a building. No hole, no water – it's that simple.

An R-2000 quality air seal in the wall assembly will greatly reduce the air flow through the wall during a rainstorm, and prevent water entry through the wall. At the Saskatchewan Research Council we have a test apparatus that is being used to check out methods for installing windows in exterior walls so that rain does not enter.

We have definitely shown that if the wall assembly is airtight, water will not leak through the wall. If, however, the assembly is loose, water will enter. A common leakage location is at the window where the jamb extension for the window is attached. The jamb extension is not normally air-sealed to the window frame and therefore air, and later water, will leak through the joints.

To properly air-seal a building, the air barrier must be continuous, durable, and most of all, buildable. Most building drawings are grossly deficient in showing air barrier details.

To summarize:

Keeping rain away from building walls involves several measures. Not all buildings need all these measures, but some do, depending on the climate and the exposure of the walls. In my next column I will address the problem of poor insulation performance.

On-Line Building Envelope Education

The building envelope courses developed by the Architectural Institute of BC are now being made available on the Internet. The first module, which focuses on building science and building envelopes, is now available. It deals with the physical processes associated with the flow of heat, air and moisture through the building envelope, and practical exercises in quantifying, calculating, and predicting the impact of environmental loads on the building envelope.

The course is designed for professionals connected with the design and/or construction of building envelopes, development of regulations and standards that apply to building envelopes, and planning and developing building projects. It is a resource for anyone interested in learning about the management of environmental loads on building envelopes.

Registrants have four months to complete the workshop to receive full credit. There are no set dates for the start and finish of the workshop, and no fixed schedule for workshop activities. Face-to-face workshop participants for this course spend about 21 hours in the classroom and an additional 40 to 50 hours studying at home. Course fee is $475.

Information about this course is available at:
http://openet.ola.bc.ca/arct501/

Or contact: Susan Finney, 604-683-8588 (professional_development@aibc.bc.ca)
or: Louis Giguere, 604-431-3294 (architecture@ola.bc.ca)

NRC·CNRC

Wall Moisture Problems and CSA's Building Durability Guideline

Premature deterioration turned BC homeowners' dreams to nightmares. Will CSA S478-95 help us to avoid repeats in other regions?

By Alan Dalgliesh

History we don't want to repeat

BC's residential building boom of the early 1990's meant that by 1996, more than 157,000 BC households were living in multi-family condominiums. As early as 1993, however, it was clear that the exterior walls of many dwelling units were in trouble. CMHC funded a "Survey of Building Envelope Failures in the Coast Climate of British Columbia" (see Solplan Review No. 72, January 1997). Rain penetration, mainly through interface details between wall and other components (e.g., windows, balcony supports) supplied the moisture allowing the growth of molds and fungi and rapid deterioration of wood framing. Poor construction of these interface details, often not shown on drawings, let water in, and various other incorrect or inadequate details (e.g. improperly lapped building paper) prevented it from draining back out.

A provincial commission of inquiry (the Barrett Commission) made its first report in June 1998. It contained a litany of major shortcomings in the design/build process. (See also Solplan Review No. 80, May 1998). The report said the immediate cause of damage was faulty design and construction, often involving the contravening of building code provisions.

Repair costs in the worst cases of wood-frame deterioration are as high as $50,000 per dwelling unit, or two to three times the price of "doing it right the first time". The total cost of all repairs will probably reach $1 billion, and that covers just the direct costs.

A guideline for durability in buildings

In January 1993, with encouragement and funding from Public Works and Government Services Canada (one of Canada's biggest landlords), about 30 building science specialists, materials suppliers, building managers, researchers and designers began drafting S478-95, CSA's Guideline on Durability in Buildings. It was published in December 1995 and was a first in North America. Intended for owners, designers, and building science professionals, S478 requires them to agree on the service lives for a building and its parts, particularly key protective components. Service life is affected by decisions made all down the line, from initial concept and design, through the construction process, to operations and maintenance. Durability of a component depends as much on exposure to destructive agents as on material properties. The building envelope gets the lion's share of attack from its immediate environment, and water in the envelope is the primary agent of destruction.

Trades are urged to discuss concerns with construction details before work starts. Designers and building science professionals need to understand deterioration processes, and to establish rates of degradation for protective components. S478 advises on selecting service lives, and how to predict them. There are sections on design, construction, maintenance and inspection, investigation of deterioration, renovation, and repair work. There are even appendices and references to other publications that can bring all parties in the developer/designer/builder/owner system to a good level of understanding on durable building design.

S478 is big on documentation and communication between all parties to the process. Sample forms are provided for assessing service lives of building components. Maintenance strategies are as much a part of design as sizing structural members or selecting cladding, and with the maintenance schedule, design information and decision forms become the "owner's operating manual".

Can guidelines head off disasters?

S478 was deliberately made a guide rather than a mandatory standard. It does not present any new or revolutionary information, but it does aim to set down, in one place, a realistic way to define and design durable buildings. The CSA committee realized that people and practices will not change overnight, and that you can't require people to take on responsibilities for durability in buildings until tools for meeting the technical challenges, and fair recompense for the extra effort involved, are in place. What you can do is to make all parties aware of the benefits of reaching a desired service life at the lowest overall cost. At the same time, owners can be alerted to the risk of ruin if the whole question of durability is ignored.

If S478 had been available at the start of the building boom in B.C., and generally applied as a blueprint for good practice in residential development and construction, it seems reasonable to conclude that the premature deterioration of building envelopes simply would not have happened. S478 is now referenced in both the BC Building Code and the Vancouver building bylaw as "good practice". The Standing Committee for Environmental Separation, responsible for Part 5 of the National Building Code, is recommending (subject to public review) that S478 be referenced as good practice in the next edition of the NBC. *(For further information contact Adaire Chown, Technical Advisor to the building code, and also S478 Committee member (adaire.chown@nrc.ca)*

W. Alan Dalgliesh is a former researcher with the National Research Council's Institute for Research in Construction where he spent 36 years and specialized in wind engineering, structural behaviour of glass, and durability of the building envelope. He was chair of the S478 committee developing the durability guideline. He now consults on building envelope matters related to wind, rain, and the structural performance of window glass, and maintains a web site for ABEC South (www.abecsouth.org). He can be reached at alandalg@home.com

Applying S478 principles in Alberta

Although S478 appeared too late to influence construction practice during the building boom in B.C., other regions of North America are still at risk. Building durability is an issue along both coasts of North America, and even in the less aggressive climate of Alberta there are signs of wall moisture problems. During the winter of 1999-2000, an investigation largely funded by CMHC was carried out on 50 dwellings built in the last ten years. (entitled "Wall Moisture Problems in Alberta Dwellings")

Builders estimated that 5% of homes built in the last five years had some form of water penetration, but several have seen a reduction of water problems in 1999 due to better training and quality control, as well as revised installation procedures. Repairs so far have ranged from a few hundred dollars to several thousand, but in marked contrast to the B.C. experience, framing or sheathing had not deteriorated enough to require replacement.

The greater drying potential and smaller number of rainy days that characterize the Alberta climate are likely the main reasons for slower rates of deterioration, but unless caught early, water penetrations eventually require costly repairs. And unless all developers and builders heed the advice in the Alberta study we could be in for a rash of wall moisture problems. Developers are forging ahead on many condos with intricate and variable new construction details, while builders try to cope with shortages of skilled trades people.

Construction practices, the need for trades training, and special measures for walls in severe exposure locations are all dealt with in the report. If the recommendations are acted on, Alberta will have an enviable reputation for problem free walls. *For more on the CMHC studies contact Jacques Rousseau, email jroussea@cmhc-schl.gc.ca.*

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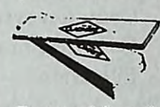

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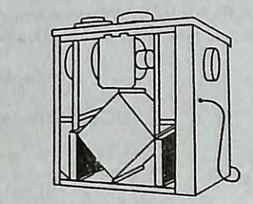

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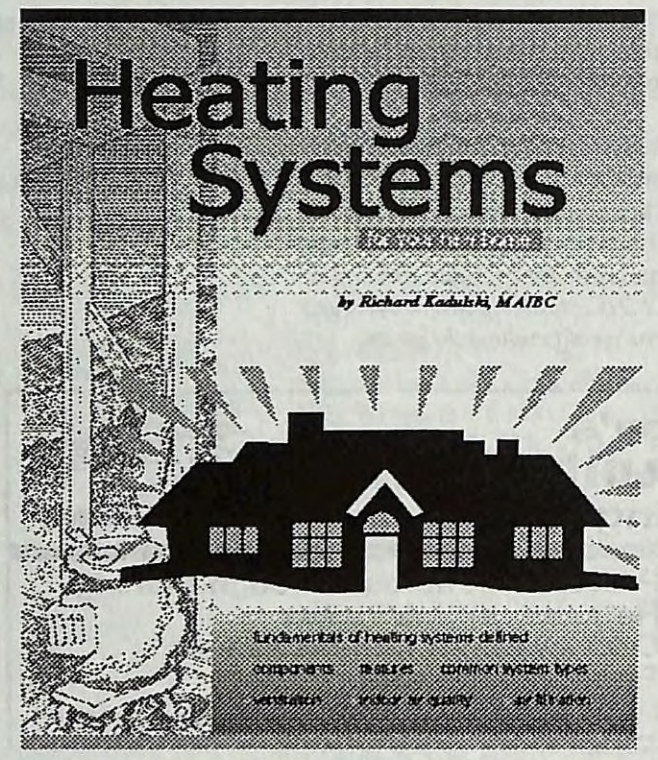

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